Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

24. Proposed by C. W. M. BLACK, A. M., Department of Mathematics, Wilmington Conference Academy, Dover, Delaware.

At the President's reception, the citizens are admitted at 12:30, but the line begins to form at 11 in front of the gate. By the time the doors are opened, there are in line 5400 people, who have gathered at a rate per second proportional to the time after 11. The President is able to receive them at the rate of 45 per second. At what time should a person have joined the line to get through with the least delay?

Solutions to these problems should be received on or before September 1st.

MECHANICS.

Conducted by B.F.FINKEL, Kidder, Missouri. All contributions to this department should be sent to him.

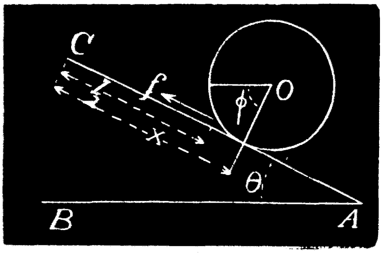
SOLUTIONS TO PROBLEMS.

7. Proposed by DeVOLSON WOOD, M. A., M. Sc., C. E., Professor of Engineering, Stevens Institute of Technology, Hoboken, New Jersey.

A hollow sphere filled with frictionless water rolls down a rough plane whose length is l and inclination θ; when half way down the water suddenly freezes and adheres to the sphere. Required the time of the decent.

Solution by J. C. NAGLE, M. A., C. E., M. C. E., Professor of Civil Engineering and Physics, Agricultural and Mechanical College, College Station, Texas.

Let the mass of water be m and the sphere a shell without weight. Then before freezing of the water the motion will be equivalent to simple sliding on a rough inclined plane.



Take origin at C, the point at which motion begins and let x be measured along the plane. Let f be the friction acting up the plane. The equation of motion for x less than $\frac{l}{2}$ is: $m\frac{d^2x}{dt^2}=mg\sin\theta-f\ldots.(1)$,

from which, by integration, $V=\frac{dx}{dt}=g\sin\theta.t-\frac{f}{m}t\ldots.(2)$,

$$\text{and } x=g\sin\theta t^2-\frac{f}{m}t^2\ldots.(3).$$

$$\text{When } x=\frac{l}{2},\ t=T\sqrt{\frac{ml}{2(mg\sin\theta-f)}}.$$

This value of t in (2) determines the value of $v=V$ at the instant the water freezes.

Now let v' be velocity of center immediately after freezing and ω the angular velocity about point of contact, which is the same as if center be regarded as fixed and the sphere revolving about that point.

Call the radius of gyration of the sphere K and we have for the effect of the impulse, since $K^2=\frac{2}{5}r^2$ for a homogensus sphere:

$$m(V-v')r=m.\frac{2}{5}r^2.\omega\ldots.(4)$$

and as the point of contact between sphere and plane has no velocity,

$$v'=r\omega\ldots.(5).$$

$$\text{From (4) and (5) } \omega=\frac{5V}{7r},\ v'=\frac{5}{7}V.$$

If ϕ be the angle through which the sphere has turned after freezing of the water, at time t. Then $x=r\phi+\frac{l}{2}\ldots.(6)$.

The acceleration along plane is given by (1) and for the motion of rotation we have $mK^2\frac{d^2\phi}{dt^2}=fr\ldots.(7)$.

$$\text{From (1) and (7) } mr\frac{d^2x}{dt^2}+mK^2\frac{d^2\phi}{dt^2}=mrg\sin\theta\ldots.(8)$$

and from (6) $\frac{d^2x}{dt^2}=r\frac{d^2\phi}{dt^2}$, which in (8) gives

$$\frac{d^2x}{dt^2}=\frac{r^2}{r^2+K^2}g\sin\theta=\frac{5}{7}g\sin\theta\ldots.(9).$$

$$\text{Then will } v=\frac{dx}{dt}=\frac{5}{7}g\sin\theta\ldots.(10)$$

$$\text{and } x=\frac{5}{14}g\sin\theta t^2+v't+C\ldots.(11).$$

When $x=\frac{l}{2}$, $t=T$ and therefore $C=\frac{l}{2}-\frac{5}{14}g\sin\theta T^2-v'T$.

(11) now becomes $x=\frac{5}{14}g\sin\theta t^2+v't+\frac{l}{2}-\frac{5}{14}g\sin\theta T^2-v'T$.

Putting $x=l$ and solving for $t=t'$, the time of decent, gives:

$$t'=\frac{7v'}{5g\sin\theta}+\sqrt{\frac{7l}{5g\sin\theta}+\frac{49v'^2}{25g^2\sin^2\theta}+\frac{14vT}{5g\sin\theta}+T^2}.$$